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HYDROTHIONURIA,

Or the Phenomenon of Sulphureted-Hydrogen Gas in Urine.

Four Cases. A Review of the Literature.

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FOUR CASES. A REVIEW OF THE LITERATURE.

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WITHIN the past three years it has been my good fortune to meet with and demonstrate chemically the presence of sulphureted-hydrogen gas in solution in the urine in no fewer than four cases.

The subject is one which has been almost entirely overlooked, alike by the practitioner and by the writer of text-books, though undoubtedly the condition of hydrothionuria occurs from time to time in the practice of many others.

Since my first case, over two years and a half ago, I have been constantly on the watch for others, with the result of having met with it three times since. In three of my cases, and in most of those recorded by others, the condition was associated with grave symptoms, and I believe that such will usually be the case.

Where such an untoward symptom does occur, it be-

hooves the physician to assume "an attitude of watchful expectancy" at least, even though he may be puzzled in his diagnosis and method of treatment.

I will first give my own four cases, with the results of the chemical tests. This will be followed by a complete review of the literature bearing on the subject, and, finally, the clinical significance of the condition:

Case I.—M. J., a negress, aged fourteen years and ten months, single, primipara. Height, five feet; weight, one hundred and ten pounds. Admitted August 22, 1890. The patient was brought to Columbia Hospital at midday, in a comatose condition, suffering with a well-marked case of puerperal eclampsia. Her friends stated that she had had twelve convulsions since two o'clock that morning. Examination on admission showed labor just beginning, the os uteri admitting the tips of two fingers. The position was occipito lævo-anterior. Temperature on admission, 101·6° F.; pulse, 112; respirations, 26. There was extreme anasarca.

The convulsions continuing with awful severity, and not yielding to chloroform anæsthesia or morphine, I performed podalic version and delivered her of a full-time dead child weighing six pounds. Soon thereafter the eclamptic attacks ceased. The urine, which was drawn by catheter three hours and a half after delivery, was intensely acid and became entirely solidified on both the heat and nitric-acid tests. On the evening of the following day the nurses came to me complaining of an overpowering odor from the patient, which I at once recognized as that of sulphureted hydrogen. This odor was so strong that it nauseated the nurses, and I myself suffered with intense headaches on several occasions while making the analyses on the following days. It was fortunate that my first case was so exceedingly well marked as to force itself upon my attention at once through the sense of smell.

This led me to make a series of careful chemical tests, all of which proved satisfactorily the presence of the gas H_2S. The following were the results of my tests, the reagents conforming to the U. S. P. test solutions.

Tests.—Urine drawn by catheter August 23, 1890 (day following delivery): Amount, 12 ounces; specific gravity, 1·015; reaction, acid; albumin present in enormous amount; penetrating odor of H_2S.

Microscopical Examination.—Heavy deposit of ammoniomagnesian phosphate; broken down blood-corpuscles; and an enormous number of active vibriones in the freshly drawn urine.

Tests for Sulphureted Hydrogen.—I. Two inches of urine in test tube + $AgNO_3$ solution (white precipitate of albumin) + HNO_3 = dark-gray precipitate at once, becoming rapidly darker and eventually exhibiting a distinct dark zone of silver sulphide (Ag_2S).

II. Urine + excess of lead-acetate solution = copious light-gray precipitate. The excess of the reagent precipitates all the albumin in the urine, and thus, by admixture of the white albumin with the black sulphide of lead, gives a gray color.

III. Two inches of urine + *one drop* of lead-acetate solution = inky black precipitate of lead sulphide (PbS), with dark-brown supernatant liquid, no white or grayish precipitate at all being caused. With this one drop of lead-acetate solution there was only an insignificant trace of albumin thrown down, yet it contained enough lead to unite with all the sulphur of the H_2S and convert it into the black sulphide of lead.

This last test, with *one drop* of lead-acetate solution, is one of the most delicate of all.

IV. Filter paper, moistened with solution of lead acetate and placed over the mouth of the jar containing the urine, gave, in the course of an hour or so, a dull-black color of a leaden luster. This is the test I always try primarily, as it is exceedingly delicate and easy to carry out.

V. Another characteristic test is made by using a solution of antimony (tartar emetic) to form the orange-red precipitate of sulphide of antimony. Two inches of urine + solution of antimony in excess of HCl = white precipitate of albumin, in which, after a few hours, a beautiful orange-red zone of sulphide of antimony unmistakably differentiates itself. This is a very beautiful test if the H_2S is present in large amount, but it is

apt to be fallacious, as it requires a few hours in which to develop, during which time the urine may be undergoing decomposition in the test jar.

VI. Heller's test. Urine + solution of iron chloride = black precipitate of $FeSO_4$. If very little H_2S is present it only causes a brown discoloration.

In this, my first case, I would draw particular attention to the enormous number of active vibriones in the freshly drawn urine. This point will be considered more fully later on when I take up the clinical significance of the condition. After the appearance of the H_2S the bladder was repeatedly washed out with a weak solution of potassium permanganate. The presence of H_2S ceased soon thereafter. In this case there is no doubt in my mind that the bacteria liberated the sulphur contained in the albumin, which was present in such enormous amount.

Case II.—J. A., female, white, aged twenty-one years; single. Admitted to Columbia Hospital, October 9, 1891, with febrile symptoms and a temperature rising every evening to 104° to 105° F. Laparotomy was done by Dr. Joseph Taber Johnson on October 14, 1891. A left pyosalpinx was found containing a fœtid, blood-stained pus. The ovary and tube of the right side were normal and not removed. Before and after the operation the patient was in an exceedingly low condition, with a temperature which ranged for many days after the operation between 104° and 106° F. She lived, however, for a year afterward, eventually dying in another hospital of phthisis pulmonalis.

Her urine was tested repeatedly, but *no trace of albumin was ever found* either before or after the operation.

On the fifth day after the operation the examination of the urine resulted as follows: Specific gravity, 1·017; reaction, faintly acid; albumin, none; odor, H_2S.

Microscopically, there were no organized deposits or bacteria.

Now, this case is exceedingly interesting. H_2S appears in the urine without a trace of albumin. Probably the hypothesis that H_2S was liberated by the action of bacteria in albuminous urine rests upon a solid foundation in my first case, but that there may be other causes for the presence of this gas in urine is rendered evident by this, my second case, in which there was no trace of albumin in the urine at any time for several weeks previous to or after the appearance of H_2S, nor were there any bacteria in the freshly voided urine seen. In this case the abdominal wound did not heal for several months, pieces of ligature silk from the pedicle being discharged on several occasions. There was always an offensive, feculent odor to the pus, *but no H_2S appeared in the urine after there was an opening established for the discharge of pus.* In this case the appearance of H_2S in the urine may be accounted for in two ways:

A. By a resorption of the H_2S from the pus-containing cavity into the blood, and its subsequent elimination through the kidneys.

B. By an exosmosis of the gas developed in the pelvic abscess directly through the living animal membrane—the bladder wall.

Case III.—M. J., the same patient who furnished me with my first case, returns in labor twenty months later with another attack of puerperal eclampsia. In passing, I may say that this case was one of those rare examples where puerperal eclampsia occurs for a second time without the patient carrying twins.

This time labor was artificially induced with a Barnes's bag and the high forceps operation performed; she was again delivered of a stillborn child. Examination of her urine showed it to contain albumin in enormous amount, and on the sixth day H_2S was present in large volume, all the tests giving satisfactory reactions. The urine during the first few days was scanty and very highly albuminous, but after a free flow was established

the H_2S disappeared spontaneously. Vibriones were present on this occasion also.

Case IV.—E. P., a negress, aged twenty-two years; quadripara. She was admitted far advanced in labor, and delivered normally of a child weighing six pounds and three quarters in L. O. A. position.

Examination of her urine revealed albumin present in large amount.

On the second day I detected the odor of H_2S, which was also demonstrated by the previous chemical tests.

Examination of urine on day following delivery: Specific gravity, 1·029; reaction, strongly acid; color, pale red; albumin, present in large amount; odor, H_2S.

Microscopical examination = red blood discs; a few leucocytes; detached vesical epithelium; *no vibriones.*

Sulphureted hydrogen was chemically demonstrated. The bladder was washed out with a solution of potassium permanganate, but I doubt if the rapid convalescence in this case was dependent on the treatment.

The patient had an excellent puerperium, the highest temperature being recorded on the second day, and only registering 101·8° F. This case is of interest in contradistinction to the others on account of the mildness of the symptoms and the complete and rapid recovery.

Review of the Literature.—After looking over the references in the *Index Medicus* of the Army Medical Library with the greatest care, I have only been able to find these comparatively few cases which I here present. The presence of sulphureted-hydrogen gas in urine was recognized as far back as 1829 by Chevallier (*Journal de chim. méd.*, 1829, i, p. 179). He mentions a case which occurred in a syphilitic woman undergoing mercurial treatment, and regards it as a phenomenon of fermentation.

Höfle (*Med. Annalen*, Bd. xi, 1845, p. 415) found H_2S in the urine in a case which occurred during a smallpox epidemic in 1843–'44.

Friedrich Betz was one of the first to devote much attention to the cause of hydrothionuria.

Betz (Ueber den Nachweis und die klinische Bedeutung des schwefelwasserstoffhaltigen Urins, *Memorabilien*, 1869, p. 1) mentions a case which occurred in a man, aged thirty eight years, of a strong constitution, who, after a night spent in hearty eating and wine-drinking, suffered with symptoms of gastro-intestinal catarrh, with much flatulence and with H_2S appearing in his urine. After a free evacuation of the bowels the H_2S disappeared.

Betz also writes up another instance (Ueber die Quellen und diagnostisch-therapeutische Bedeutung des H_2S im Urin, *Memorabilien*, 1874, xix, pp. 66–69). This was the case of a man, aged seventy-nine years, who had H_2S in the urine for a protracted time. The post-mortem examination showed hypertrophy of the prostate, which interfered with the emptying of the bladder and caused diverticula of the bladder walls in several directions.

One of these diverticula, which was exceedingly thin, pressed closely against the rectum, which, bulging out like an ampulla, was filled with stagnant fæces. In this case the conditions were peculiarly favorable on account of the exceedingly thin diverticulum which pressed upon the rectum, while the bladder in its normal anatomical relations only presents a small area to the abdominal cavity.

The fresh urine in this case had a penetrating, feculent odor of H_2S, weakly acid reaction, specific gravity of 1·003 to 1·005, and contained no albumin.

Microscopical examination showed pus-corpuscles, epithelial cells, and vibriones. The catheter, which was made of silver, was discolored black by the H_2S.

Betz found that the fæces in this case contained more than the usual amount of H_2S, and that the quantity of H_2S in the urine and bowel took a parallel course.

It is important to note that the ureters were as thick as a finger and that there was suppurative atrophy of the kidneys.

Betz enunciates three theories of causation as follows:

I. The H_2S develops in the bladder from a decomposition of albuminoid bodies, such as pus, blood, etc.—a rare cause.

II. H_2S appears in consequence of its resorption from the intestine into the blood and its subsequent elimination through the kidneys.

III. The H_2S appears in the urine on account of the exosmosis of the gas from the intestine into the bladder.

H. Emminghaus has fully written up two cases (Zwei Fälle von mehrfacher Perforation des Verdauungscanals und Schwefelwasserstoffgehalt im Urin, *Berl. klin. Wochenschr.*, 1872, S. 477 u 491). The first case occurred in a woman, aged twenty years, who was admitted to the hospital at the end of February, 1871, suffering with gastric ulcer. She died in collapse and with slight convulsions after being in the hospital about a week. There was a perforation between the pyloric and cardiac orifices near the small curvature of the stomach, the small intestine was perforated twice, and the sigmoid flexure once. Four days after, H_2S appeared in the urine.

His second case occurred in a man, aged twenty years, who was admitted to the hospital March 19, 1871. He was so ill that no history could be obtained, but on post-mortem examination there were found abscesses in the small intestine, vermiform appendix, and sigmoid flexure.

In both these cases and the one of Betz's it would seem that the H_2S appeared in the urine by exosmosis through the bladder wall and its absorption into the urine.

Johannes Ranke (*Lehrbuch der Physiologie*, iii. Aufl., S.

530) made an experiment of very great importance in the study of this phenomenon. He found that if a few drops of the urine which contained the H_2S were added to other normal urine, H_2S would develop in the latter, and again a third specimen of normal urine could be inoculated from the second.

Ranke says (translation): "There is no doubt that in the formation of H_2S in urine we are dealing with the phenomenon of fermentation, which I call H_2S-fermentation. . . . The development of H_2S in urine can only take place in acid and neutral urine and not in alkaline."

His experiment would go to prove that the property of developing H_2S was contained in the organic ferments of the urine which contained the H_2S, by reason of certain fungous substances peculiar to it.

Müller (Ueber Schwefelwasserstoff im Harn, *Berliner klin. Wochenschr.*, 1887, xxiv, 405, 408, 436) verifies the above-mentioned experiment in every particular, and says that the addition of the very smallest quantity will suffice to cause the inoculated urine to become turbid. Müller says that not every urine can be so inoculated, especially those urines which are highly concentrated, as in infectious diseases, peritonitis, and ileus, which contain a large quantity of phenol and indigo-forming substances which are toxic to the micro-organisms.

Rosenheim and Gutzmann (Zur klinischen Würdigung und Genese der Schwefelwasserstoffausscheidung im Urin, *Deutsche med. Wochenschr.*, Leipsic, 1888, xiv, 181–184) present three cases. Their first case was that of a man, aged fifty-five years, who had a retro-strictural abscess which communicated through a fistulous opening directly with the bladder. The patient died after a very short course of the disease without affording much opportunity for study. The post-mortem showed a direct communication of the bladder

with an abscess cavity, which precluded the theory of gas diffusion in this case.

Their second case was a most interesting one, in a woman who entered the hospital suffering with pains in the left side under the arch of the ribs, and an irritable bladder, which led them to diagnosticate the case as vesical catarrh. On the fourth day the urine attracted attention by its penetrating odor of H_2S. From this case they succeeded in isolating little rods by culture, which, transplanted in other urine after the method of Ranke, produced H_2S in the second specimen of urine. The H_2S disappeared spontaneously after eight days, although the bladder catarrh continued. The patient left the hospital, but soon thereafter returned with the same complaint, yet no H_2S could ever be discovered, while under the microscope there were a number of bacteria identical with those seen before. They do not mention whether the urine was albuminous or not.

Their third case occurred in a woman, aged seventeen years, who came into the hospital suffering with parametritis, inflammation of the vaginal mucous membrane, and pain on pressure in both inguinal regions. Both tubes and ovaries were thickened and surrounded by exudates. There was erosion of the portio vaginalis uteri. This to me seems most likely to have been a case which was septic and probably gonorrhœal in origin. In the light of the present pathology of perimetric inflammations they were probably wrong in calling it a case of parametritis. The vast majority of cases such as is here described are cases of pyosalpinx with a plastic exudation round the ostia abdominalia binding together the fimbriæ and ovaries. Very probably in the center of this "mass" or "exudate" there was a degenerating pus sac which formed the H_2S. Soon after the relief of the vaginal inflammation she was attacked with

cystitis and had to be catheterized. The urine was acid, free of albumin, without any leucocytes, and turbid from masses of bacteria in it, and smelled of H_2S. Soon the urine became clear, the bacteria diminishing, but the odor of H_2S continuing. Soon thereafter the H_2S reaction disappeared. After eight days the bacteria again appeared in enormous numbers in the urine and the H_2S reaction again became distinct. Gradually the bacteria disappeared, and the H_2S reaction as well.

Here there is a distinct parallel between the presence of H_2S and the quantity of bacteria in the urine. They suggest that the bacilluria might have been caused by masses of bacteria which passed through the bladder walls from the neighboring inflammatory area.

From this urine they succeeded in isolating a very markedly characteristic species of bacillus which they considered as the cause of the hydrothionuria.

They convinced themselves by experimentation that this species of bacteria had the power to act reducingly upon the sulphur-containing substances in the urine, and in this above-mentioned case they consider it to have been the sole cause.

Müller (*loc. cit.*), making experiments at the same time and independently, showed that other micro-organisms were capable of developing H_2S in the same manner. I shall refer to these experiments more fully later on.

Rosenheim and Gutzmann further made experiments to show from what substances present in the urine H_2S was developed. They placed their bacteria in nutrient liquids, to which they added traces of albumin, but were never able to observe the formation of H_2S, while, on the other hand, the same micro-organisms placed in other urine free of albumin developed the H_2S reaction. The question then arose to them, "Which of the sulphur-containing substances

was the source of the H_2S?" According to Neubauer and Vogel (*Anlty. zur Analyse d. Harns*, ii. Auflage, 1856), whom they cite, the source of the H_2S would be in the sulphates, which form H_2S in the presence of moist organic substances at a moderate temperature. They quote Pfeffer as saying that with the presence of sulphates certain fungi reduce these sulphates to H_2S. They support this by the following experiment: Normal fresh urine was freed from sulphates and then inoculated from urine which contained H_2S. Not a trace of H_2S was developed in it. Müller (*loc. cit.*), however, did succeed in developing H_2S in urine freed from sulphates by transplantation of bacteria.

Rosenheim and Gutzmann believe that the H_2S-producing sulphur belongs to a class of sulphur compounds normally existing in urine, and they say that very possibly it may be hyposulphurous acid, which is peculiarly apt to develop H_2S with facility.

Friedrich Muller (Ueber Schwefelwasserstoff im Harn, *Berl. klin. Wochenschr.*, 1887, xxiv, 405, 408 u. 436) mentions a case which occurred in a servant girl, aged twenty-nine years, who suffered with phthisis pulmonalis. The urine sediment contained numerous leucocytes, bladder epithelium, and crystals of triple phosphate, and it gave a strong reaction of H_2S. The H_2S reaction was more pronounced when the urine remained for a long time in the bladder than when drawn by catheter soon after its secretion from the kidneys.

On post-mortem there was found a very small recto-vaginal fistula which had been there since the birth of her child six years previously. Faeces passed through this fistula and probably infected the bladder by passing up the urethra, thus causing a cystitis.

Müller found no H_2S in the urine of patients who had H_2S in the sputa or vomited matters, nor in patients who

took sulphur baths and inhaled large quantities of H_2S, nor did he find it in cases of gastric ulcer and typhoid fever with perforation. He has never found it where there has been a pus sac adjacent to the bladder, not even if that pus sac contained H_2S in large amount. In his experiments on animals he found that only by injecting lethal quantities of H_2S, or of sodium sulphate in solution, into the abdominal cavity, could he cause H_2S to appear in the urine. He does not believe that diffusion through the bladder walls often occurs, but that in every case in which the urine contains H_2S it has undergone decomposition, yet not every decomposed urine contains H_2S.

He further says that hydrothionuria is a very common phenomenon in all possible forms of cystitis, not only in the slight degree, as is so often found in females as a sequela of leucorrhœa, but also in the more serious diphtheritic diseases of the mucous membrane of the bladder.

He says some specimens of normal urine left exposed to the air, especially at a warm temperature, will develop H_2S, and from these specimens which do develop H_2S other urines can be inoculated. He found, out of many kinds of micro-organisms which develop in urine, two kinds which especially develop H_2S. One kind was an oval-shaped coccus, 8 μ in diameter, which often forms diplococcus and liquefies gelatin quickly.

The other organism was larger, was round, did not liquefy gelatin, and formed H_2S very slowly.

He believes that other micro-organisms can form H_2S, but he only wants to prove that they do form it, and not what kinds form it. Albumin is not the cause, because urine free of albumin and peptones can be inoculated and develop H_2S.

Müller concludes that hydrothionuria is in most cases a result of decomposition in urine caused by certain micro-

organisms. The appearance of H_2S which has been absorbed from other parts of the body—*e. g.*, intestines, kidneys, or from neighboring pus or gas collections—occurs but rarely, he thinks, and then only if the quantity of H_2S is so great that general toxic phenomena have resulted. This latter theory, he says, could only be accepted if the urine was examined immediately and no trace of decomposition found.

Sertoli (Sull' essistenza di uno speciale corpo solforato nell' orina, *Gazett. med. ital. lomb.*, 1869, Ser. VI, ii, 197) found that with the addition of any mineral acid and heating to 100° C., any urine would give off H_2S.

Senator (*Berliner klin. Woch.*, 1868, p. 254) mentions a case of hydrothionuria where an error in diet caused a catarrh of the stomach and a general intoxication of the whole system by H_2S poisoning, with the evolution of large quantities of H_2S from the mouth, and it also appeared in the urine in such great quantities that it colored a visiting-card containing lead black.

J. Vogel (Neubauer and Vogel, *Anltg. zur Analyse d. Harns*, 2te Auflage, 1856) says that he had had an opportunity for a long time to observe hydrothionuria in a man who had paralysis and who had to be catheterized. The urine was faintly acid and pale yellow, with some sediment, and gave a strong reaction of H_2S with lead acetate.

Löbisch (*Harnanalyse*, 2te Auflage, S. 354) observed H_2S in the urine in a patient convalescing from typhoid fever. It had no trace of albumin.

C. A. Cameron (*Notes on Pathology of Urine*, 1880) had a case of hydrothionuria in a middle-aged man who suffered for two years with H_2S in his urine. I add also another peculiar case which he mentions of a young girl, who, though in good health, had H_2S eliminated through the perspiration after exercise. The urine examination was not mentioned.

Härtling (*Ueber das Vorkommen von Schwefelwasserstoff im Harn*, 8vo, Berlin, 1886) presents a case of gangrene of the right lung and feculent cystitis. The sputa contained H_2S. The urine was acid, with a specific gravity of 1·011 to 1·024. Albumin was present, as well as leucocytes, but there were no tube casts. Eventually H_2S appeared also in the urine, but, after an observation of a month and a half, the patient was discharged cured.

Eichhorst (*Pathologie u. Therapie*, vol. ii, p. 647) says that in certain diseased conditions H_2S appears in the urine, and that it can be known by its coloring a silver catheter black. He mentions no cases.

Heller (*Arch. f. phys. u. path. Chem. u. Mikrosk.*, 1844, p. 24) found H_2S in the urine of a tuberculous patient suffering from pneumonia. He said that it was decomposed urine.

L. Kolipinski (*Med. News*, Philadelphia, Feb. 6, 1892, vol. lx, No. 6, p. 154) had a case of hydrothionuria in a man, aged sixty-seven years, who was an inebriate and suffered with chronic gastritis. He had profuse incontinence of urine and an enlarged prostate gland.

On June 5, 1891, the urine examination showed "a red color; acid reaction; slight turbidity; no sediment; specific gravity, 1·018; no albumin, bile, or sugar. Lead-acetate paper gave the H_2S reaction."

The urine continued of this same composition for a month, and H_2S was always present. "At the end of the month the patient's condition grew worse. . . . There now appeared a new light to clear up the mystery of the H_2S. The patient began to complain of pains about the anus at the site of a former ischio-rectal abscess. There was found on the right side, around a small, circular cicatrix, a moderate degree of induration, extending forward to the sacral fold, slightly tender and fluctuating. A free incision gave

exit to about an ounce of pus having a strong odor of H_2S. The abscess was thoroughly washed out and left clean and dry."

On the night of this day (July 4, 1891) the urine was drawn by catheter twelve hours after the abscess had been opened, and presented the following characteristics: "Color, red; acid reaction; specific gravity, 1·019; slightly turbid; opaque sediment; a trace of albumin; indican in excess; granular epithelium and blood corpuscles. H_2S was still present."

H_2S was not again found in the urine, though on the following day or so he had a severe diarrhœa, with offensive stools and undigested material, which showed the existence of gastro-intestinal indigestion. He died on the 13th of July.

The autopsy, which was confined to the abdominal cavity, showed a dilated stomach; cirrhotic kidneys, the right one containing several small cysts and calcareous infarctions. The liver was in a condition of fatty degeneration; the spleen was dark and friable, but not enlarged; the gall-bladder contained two small calculi; there was no fluid in the abdominal cavity. "The ischio rectal abscess was thoroughly explored and found empty and granulating. The bladder was contracted, and there was no induration or inflammation in its neighborhood. . . . Here was an old ischio rectal abscess (the residual variety of Paget) for a long time manifesting itself only by the presence of a decomposition product in a natural secretion."

This case bears some similarity to my second case, in which there was a pelvic abscess with an offensive, feculent odor to the pus. In that case, as in the one mentioned by Dr. Kolipinski, no H_2S appeared in the urine after there was an opening established for the discharge of pus.

The bacterial origin of the H_2S in such cases as these seems doubtful.

Austin Flint (On the Elimination of H_2S artificially introduced into the Body, *Med. News*, Philadelphia, 1887, vol. li, p. 670–'73) made experiments to ascertain the value of the Bergeon treatment of pulmonary phthisis by H_2S gaseous enemata, the object being to have H_2S eliminated by the lungs and destroy the tubercle bacilli. He tried gaseous enemata of H_2S to see if it could be eliminated by the lungs; he never succeeded after the injections in detecting it in the breath of a human being, but did find it in the breath of a dog on one occasion. A piece of white filter paper, moistened with lead-acetate solution, was held before the mouth for the detection of the gas. In the case of the dog the elimination only lasted for three minutes. He has repeatedly injected H_2S into the veins of dogs, and has always noted a prompt elimination by the lungs, but this lasted for only a few seconds after the injection was discontinued. He did not find H_2S in the urine of these dogs. Flint says: "It would appear from these observations that a certain quantity of H_2S introduced, even in saturated aqueous solution, may be destroyed in some way in the system without being eliminated as H_2S."

Out of all the literature on the subject I have only been able to find these comparatively few cases. It is difficult to actually demonstrate the cause or causes, but we can arrive at pretty certain conclusions from the material presented. I believe that the condition of hydrothionuria exists much more frequently than it is recognized, especially in cases of feculent cystitis. Its diagnosis is of the utmost importance, when it does occur, in leading us to the therapeutic measures to be adopted. The condition, from whatever cause it originates, demands that the diagnosis be accurate, whether there are neighboring pus sacs, stagnant and decomposed fæces, gastro-intestinal catarrh or perforations, or bacilluria.

The possibility of the diffusion of gases through animal membranes is recognized by all physiologists.

Müller (*loc. cit.*) does not happen to have found H_2S in the urine when there was rupture of the viscera with escape of H_2S into the abdominal cavity, nor where there were pus sacs adjacent to the bladder, nor could he cause it to appear in the urine of animals except by injecting lethal quantities of H_2S or sodium sulphate into the abdominal cavity. But the observations of others antagonize this; for instance, Senator's case, where there was general poisoning with H_2S resulting from an error in diet; my own case, No. II, where there was a pelvic abscess adjacent to the bladder; the case of Betz's, where a very thin diverticulum of the bladder pressed closely against the rectum, which was filled with stagnant fæces and contained an unusual amount of H_2S; the two cases of Emminghaus's, in the former of which there were numerous perforations of the alimentary canal, and in the latter abscesses in the small intestine, vermiform appendix, cæcum, and sigmoid flexure; and Kolipinski's case, in which there was an ischio rectal abscess containing H_2S.

Charles B. Kelsey, in an article on abscesses round the rectum (*Therapeutic Gazette*, Philadelphia, vol. xvii, No. 1, Jan. 16, 1893), says that the pus in abscesses round the rectum often has a fæcal odor from proximity without actual perforation. This is known to all surgeons.

I therefore consider that the *diffusion of the gas* from a neighboring pus sac, or from an intestine containing an unusual amount of H_2S, directly through the bladder walls, is *one* of the causes of hydrothionuria. I place little credence in Betz's second theory—"that H_2S appears in consequence of the resorption from the intestine into the blood and its subsequent elimination through the kidneys."

Müller and Austin Flint (*loc. cit.*) have both shown that

H_2S can be made to appear in the urine only by injecting lethal quantities either into the abdominal cavity or veins. Husband (*Forensic Medicine*, fourth edition, page 379) says: "When the gas is but slightly diluted the person becomes suddenly weak and insensible and rapidly dies. The post-mortem appearances are fluidity and blackness of the blood, loss of muscular contractility, and a tendency to rapid putrefaction. The bronchial tubes are reddened, and the internal vascular organs appear almost black."

In order to be absorbed into the blood and subsequently eliminated by the kidneys, the H_2S would have to be present in such enormous amount as to cause speedy collapse and death—a condition which was present in none of the cases.

The experiments of Ranke, made also by Müller and Rosenheim and Gutzmann, prove conclusively the *bacterial origin of a large class of cases of hydrothionuria*. Ranke proved that a few drops of urine containing H_2S on being added to other normal urine caused H_2S to develop in the latter by a process of fermentation. Rosenheim and Gutzmann (*loc. cit.*) discovered a bacillus in the urine which developed H_2S in other urine, and Müller (*loc. cit.*) discovered two forms, one an oval shaped coccus 8 μ in diameter, and the other which was a larger organism.

In Cases I and III of my own series the urine swarmed with vibriones, and, when these were killed by irrigating the bladder with a solution of potassium permanganate, the H_2S soon disappeared.

Müller found that some specimens of normal urine left exposed to the air, especially at a warm temperature, developed H_2S, and from these specimens which did develop H_2S other urines could be inoculated. Just what substances the bacteria split up to form H_2S it is difficult to say. Extreme albuminuria in eclamptic cases was present in two of my cases, and albumin was present in some of

the other cases also. When we consider the large proportion of sulphur contained in albumin, it is not hard to understand how it may be one of the substances present in urine out of which H_2S may be formed. In the two cases referred to above, where there was a dense precipitate of albumin on testing it and an enormous number of active vibriones, I conceived the idea that the process was analogous to the formation of H_2S during the putrefaction of an egg. But Rosenheim and Gutzmann have positively shown that the presence of albumin is not necessary, and that other substances present in the urine can produce it. These are probably the sulphates; but even this supposition is rendered difficult since Rosenheim and Gutzmann succeeded in developing H_2S in urine which was previously freed from sulphates. Müller, however, could not cause it to develop in urine freed from sulphates.

I believe that *any of the sulphur-containing substances present in the urine may at times be the source of the H_2S.*

The clinical significance of hydrothionuria varies according to the circumstances under which its development occurs. In some cases we must reduce the clinical significance of H_2S in the urine to a *bacillaria*, in others to a *diffusion of the gas* from a neighboring pus sac or bowel containing a large amount of H_2S. The decomposition of the urine occurs after its secretion either in the bladder, ureters, or pelves of the kidneys, on account of the action of bacteria. It is not essential to find any particular kind of micro organism to explain it, but simply to accept as proved that various kinds have been found to split up the sulphur containing substances in acid urine.

Hartling (*loc. cit.*) says that every urine remaining exposed to the air eventually develops H_2S, so this precludes the idea of assigning the cause to any particular kind of micro-organism.

The therapeutic measures to be adopted will depend upon the cause. If the intestinal canal is filled with stagnating gases and fæces, we should freely purge the patient and administer intestinal antiseptic drugs. If there are neighboring pus sacs—for instance, pyosalpinx, pelvic abscesses, ischio-rectal abscesses, or tubercular ulcerations of the bowel, bladder, or internal organs of generation—we should evacuate the pus and drain according to surgical methods.

If the condition is associated with a cystitis and bacilluria, as will in most instances be the case, we should wash out the bladder with antiseptic solutions of permanganate of potassium or peroxide of hydrogen or other substances suitable for bladder irrigation.

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